THE

KANSAS UNIVERSITY SCIENCE BULLETIN.

Vol. IX, No. 16—September, 1915.

(Whole Series, Vol. XIX, No. 16.)

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SOME METHODS OF STUDYING FOSSIL AMPHIBIA EMBEDDED IN COAL.
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PUBLISHED BY THE UNIVERSITY,

LAWRENCE, KAN.

Entered at the post-office in Lawrence as second-class matter.

5-2496

KANSAS STATE PRINTING PLANT.
W. R. SMITH, State Printer.
TOPEKA. 1915.

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VOL. IX, No. 16.] SEPTEMBER, 1915. [WHOLE SERIES VOL. XIX, No. 16

Some Methods of Studying Fossil Amphibia Embedded in Coal.

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Contribution from the Zoölogical Laboratory, No. 216.

Plate L.

THE study of fossils embedded in soft coal or shale has always been somewhat of a problem. Various means have been devised for the interpretation of the elements preserved, all of which have good points for the material in which the fossils are enclosed. The fossils embedded in coal are nearly always very fragile, or else only a mold of the skeleton is preserved, and the problem for the student is how best to obtain an idea of the form of the animal and still preserve the material for future investigators.

Jaekel (1) has devised a method by means of which the bones are removed from the coal, either by mechanical means or by chemicals, and impressions made of the mold either in wax, gutta-percha or plaster. He has been followed in this by his student, Schwarz (2). Their results are uniformly excellent, though their interpretations of the elements may, in some cases, be open to question. In regard to the methods of study Schwarz says:

"Der Erhaltungszustand ist im allgemeinen recht schlect. Dies gilt besonders von den amerikanischen Formen und . . . in der erwähten Arbeit betrachtet, an denen oft kaum die Umrisse

Received for publication May 12, 1915.

zu erkennen sind, viel weniger irgend welche Einzelheiten der Organization. Hier konnte nur eine gründliche und sorgfältige Präparation zum Ziele führen. Es wurde dabei durchwegs-im Anschluss an die oft mit grossem Nutzen angewandte Methode Jaekel's der Knochen entfernt, wobei verhaltnissmässig gute Negative erhalten wurden. Eine grosse Erleichterung war dadurch ermöglicht, dass sich die Knochensubstanz in Salzsäure löst, während die Kohle nicht angegriffen wird. Die übrigbleibenden Teilchen des Knochens wurden dann mit der Nadel unter starker Vergrösserung entfernt.

"Fur die Abdrücke wurde zum grössten Teile Guttapercha dann aber auch Gips und in geringerem Masse auch Gelatine und Wachs verwendet." (p. 64.)

Much the same method has been employed by McGregor (3) in his study of *Meosaurus brasiliensis*, which was embedded in a black bituminous shale from the Permian of Brazil. He says:

"The matrix containing most of the remains is black bituminous shale, which splits rather readily in the plane of the specimen thus exposing, in some cases, almost the entire skeleton. The skeletons found in the bituminous shale are almost completely carbonized, and occasionally covered with a delicate pellicle of pyrite. They are much softer than the matrix, very friable indeed, and crumble badly on exposure to the air. Owing to this crumbling, it was found that the only way to study the remains satisfactorily was carefully to remove the carbonized bones and to take casts of the molds. From these natural molds or negatives, gelatine positives were first made, then, from these gelatine negatives, and from the gelatine molds final positive casts were made in plaster of Paris. Aided by careful comparison with the originals and with the gelatine positives, the plaster casts were colored to differentiate bone from matrix, and thus they illustrate the skeletal structure more clearly than do the originals."

The fossils studied by the writer were of such a nature that neither of the above methods was possible. This was due to the fact that most of the material was borrowed from the American Museum of Natural History, and the specimens representing the species are not sufficiently abundant to admit of preparation. Furthermore, a great many of the specimens studied were Cope's types, and as such, of course, could not be disturbed. Under these circumstances new methods of study had to be devised.

The fossils from Linton, especially, are all embedded in a soft coal, which is usually much broken, as if it had been picked up from the mine dump. The skeletal elements in all

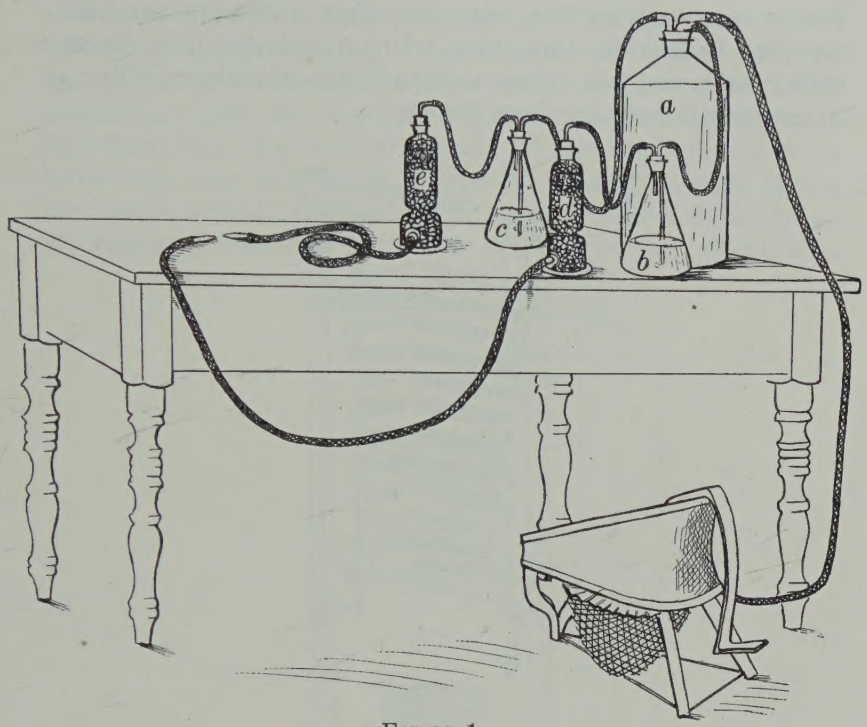

FIGURE 1.

1. Apparatus for whitening dark or black fossils in order to bring out details for photographic and study purposes. A foot bellows with a long tube attached through which the air is forced into the reservoir *a*. From this reservoir pass off two tubes leading through two wash bottles, *b* containing C. P. HCl, *c* containing C. P. NH_4OH. The fumes from these are carried through drying towers containing chloride of lime, *d* and *e*, to take out all moisture; then the fumes are mixed at the tips of the glass canuli, forming a white deposit of ammonium chloride (NH_4Cl) on the object to be studied or photographed.

cases are completely carbonized and crushed flat. In some cases a thin carbonaceous pellicle adhered very closely to the fossils, and this was difficult to remove. The Linton fossils are all black, and can only be detected by close scrutiny in certain lights. The important thing was to treat the specimens so that the fossils would be distinct in ordinary lights. This was done by an apparatus (figure 1) which deposited ammonium chloride in a tenuous layer over the fossils. The apparatus consists of a bellows, or a mouth tube, to blow air through the

tubes; two wash bottles, one containing chemically pure ammonium hydroxide, the other with chemically pure hydrochloric acid; and two drying towers filled with calcium chloride to extract all moisture from the air.

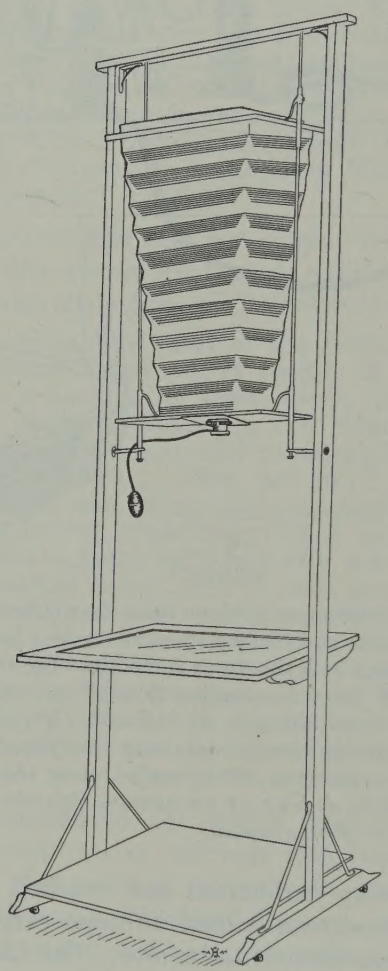

FIGURE 2.

A vertical camera designed especially for making photographs of large delicate objects. By means of a clear-glass background shadows are eliminated. This camera was designed and made by Dr. S. W. Williston.

The fossil could then be photographed and the photograph used as an illustration, or, if the details were still obscure, as an aid to studying the specimen under the binocular. The apparatus which has been found of the greatest convenience in photographing the smaller fossils (figure 3) consists of a heavy iron base into which is fastened an upright steel bar an inch and a quarter in diameter, to which is fastened, by means of clamps, a base and a rod for the support of the camera.

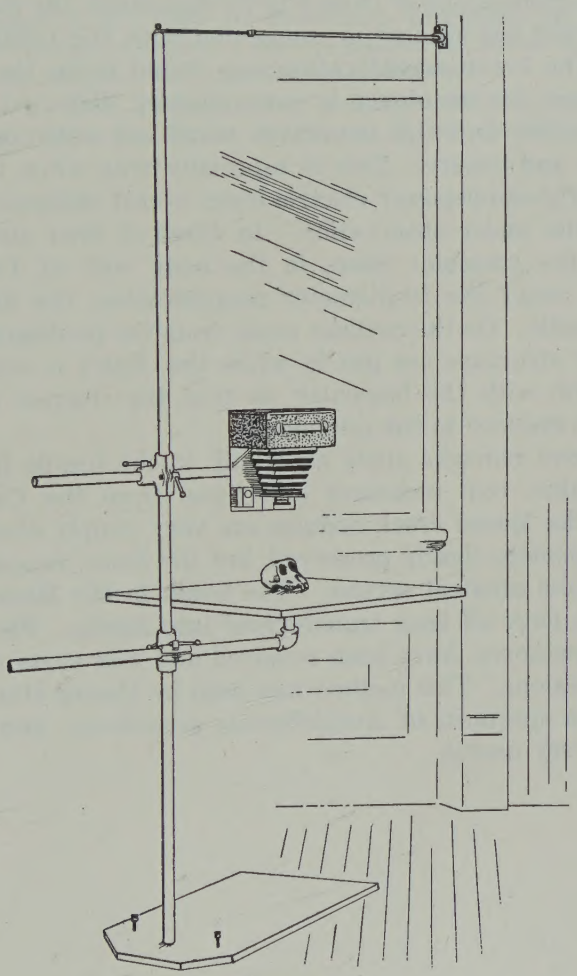

FIGURE 3.

A vertical camera stand, useful in making photographs of small objects.

Either base or camera can be moved at will up or down the vertical rod. Another type of camera which is of great value, especially for larger fossils, is the one shown in figure 2.

Prints made from the negative are often used for illustration, but in case the photograph is not clear enough for publication, outlines are taken either from the print or from the negative. The fossil is then placed, with the coating of ammonium chloride still adhering, under a Zeiss binocular where, under magnifications of from 8 to 50 diameters, the characters of the fossil are studied in connection with the photographic print. The lower magnification was found to be the best in most cases, for no object is even slightly distorted by this magnification, and the structures stand out with surprising clearness and beauty. This is especially true when the light from a fifty-candlepower electric lamp is cast obliquely on the fossil while under observation. In cases of finer structures, such as the muscular fibers in the body wall of *Tuditanus walcotti,* under the 50-diameter magnification, the light was indispensable. On the outlines made from the photographs the details of structure are put in while the object is still under observation with the binocular, so that the chances of error have been reduced to the minimum.

The above remarks apply especially to the fossils from the Linton, Ohio, coal measures and those from the Cannelton slates. The Mazon creek nodules are very simply studied for they are usually clearly preserved, but the Zeiss binocular was found of the greatest service. The bones in the Mazon creek specimens have all been transformed into kaolin. The bones, in some instances, have been removed and wax casts made of the impressions. This method was used by Doctor Hay (4) in studying a specimen of *Amphibamus grandiceps,* and I have found it very useful.

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